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## Technical Memorandum

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The Problem

To estimate the capability of the Trans-Siberian Railroad to transport from Leningrad to Vladivostok, a stripped submarine weighing 100 metric tons with the following dimensions:

	Feet	Meters
Length	150	45.72
Width	12	3.66
Height	14	4.26

Conclusions

A preliminary analysis of evidence available indicates that a stripped submarine of stated dimensions could probably be moved over the Trans-Siberian Railroad between stated points providing the profile of the submarine tapers toward the top as discussed in following Section (g).\*

Discussion

A preliminary analysis of available evidence indicates that a stripped submarine of stated dimensions could probably be moved over the Trans-Siberian Railroad from Leningrad to Vladivostok. A definite conclusion on this problem, however, cannot be reached without further data on the profile of the submarine, since the clearance diagram for Soviet railroads is narrower at the top than at the bottom. In this paper it has been assumed that the submarine tapers toward the top of the profile.

- (a) S/Tr has no comment on the design of a cradle to carry the hull. Whatever the design of such a cradle, it would have to be pivoted as indicated in Section (f) of this paper. The 45.72 meter long submarine could be carried on three 60-ton capacity flat cars, each about 16.9 meters long.\*\*

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\*\* While there is no definite information available that the USSR has flat cars of exactly this length, the following evidence indicates that it does: Gudok of 2 August 1961 reported that the Dneprodzherzhinsk plant was producing new 60-ton flat cars two meters longer than earlier models. The standard 60-ton flat car of the USSR is 14.9 meters long over the buffers; therefore, the new models probably have a length of about 16.9 meters. Three cars of 16.9 meters length would accommodate a total length of 50.7 meters.

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- (b) & (c) The permissible axle loading would not be exceeded even if weight of the submarine were carried entirely on only two of the three flat cars. Assuming that the 16.9 meter long cars have a tare of 25 tons (the standard 14.9 meter long flat car has a 22.0 ton tare), and that the 100 ton submarine would be supported on the two end cars, each of the two cars would have a gross weight of 75 tons. The permissible axle load per running meter of track is 6.5 tons and 8.0 tons on some reconstructed sectors (K.V. Kazimirov, "Vagony-tsisterny," Moscow, 1950) which when multiplied by 16.9 meters gives a maximum permissible gross load of 110 tons per car. This is considerably above the gross load of 75 tons per car required to move the submarine, and would have a considerable margin for the weight of pivots, cradles, and other supports.
- (d) No comments.
- (e) S/Tr has no readily available information on the minimum radii of curvature in Leningrad. It would be necessary to study large scale maps and aerial photographs to determine whether the sharpest curve in the city is greater than that found on the Trans-Siberian railroad. While it is quite likely that this is the case, the spacing between track centers at stations is probably 5.3 meters (Zheleznodorozhnyy Transport, No. 7, 1947), compared with a spacing of 4.1 meters between stations. It is possible that this wider spacing is also found on curves within cities on sections of track outside the station areas.
- (f) The Trans-Siberian railroad is believed to have a minimum radius of curvature of 5°28' or about 1050 feet radius per chord of 100 feet (Engineering, 18 November 1904, p. 687). Assuming that this maximum curvature occurs in either a single tracked cut or tunnel, and with a maximum clearance of 4.9 meters (as shown in Section g), there would be sufficient clearance to move the 45.72 meter long submarine around the curve as shown in Tab A. If the minimum radius of curvature occurs in a double tracked tunnel or cut, there is even greater clearance. The location of the two pivots on which to secure the submarine is found at

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the intersection of the center line of the track with the center line of the submarine (see Tab A). The ends and centers of the submarine could be supported on transverse beams greased to permit the movement of the cars beneath the rigid submarine.

- (g) The profile of the submarine might present difficulties because the clearance profile of Soviet railroads may not be large enough to accommodate the top of the submarine unless it is tapered. The Soviet 2-S profile is found on lines built since 1926, and on lines which were double tracked before 1926. The latter category includes the Trans-Siberian railroad (CIA, FDB Translation 160, "Loading Gauges of Railroads in German-Occupied Russian Territory", 28 June 1948). The 2-S profile has the following dimensions:

Width: 4.8 meters, at mid-level of car; *2.04 meters, at top of profile*  
Height from top of rails: 6.4 meters

Following were the maximum dimensions permitted in 1945 for equipment shipped in boxes which were to be transported on USSR railroads:

Width: 3.25 meters, at base of box  
1.238 meters, at top of box  
Height of box: 4.0 meters  
Length: 13.0 meters

If a box had dimensions exceeding these, approval had to be obtained from the Soviet Government Purchasing Commission [REDACTED]. There is, however, no information available to indicate the maximum dimensions of a shipment which would have been approved by this Commission. It is likely that the maximum permissible dimensions would have equalled those for the greatest width of car permissible on lines with 2-S profiled (CIA, FDB Translation 160):

Width: 3.6 meters, at mid-level of car  
2.1 meters, at top of car  
Height from top of rails: 5.3 meters

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A comparison of the dimensions of the submarine with the last listing indicates that the submarine would be 0.08 meters wider than the maximum permissible car width. This would cause no major problem because the normal distance between centers of adjoining double tracks is 4.1 meters. Assuming the top of the flat car to be 1.08 meters above the level of the rails, and combining it with the submarine's height of 4.26 meters, gives a total height of 5.32 meters from the top of the rails. This would be 0.02 meters higher than the maximum permissible height of a freight car. The top of the submarine could not greatly exceed the 2.1 meters width at the top of the car which is shown above.

- (h) This large rigid object would probably travel in a special train, and would have to be moved at very low speeds within cities, in station areas, across bridges, and in mountainous regions. This would undoubtedly retard the eastbound flow of traffic on the Trans-Siberian railroad during the time the submarine was moving from Omsk to Vladivostok. A study of the effect of such a movement is not possible within the allotted time for this response.

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